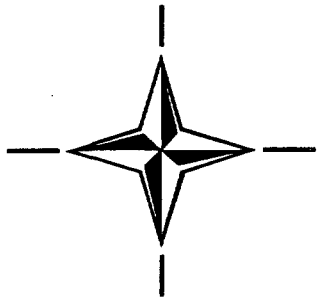
STANAG No. 4239
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)



MILITARY AGENCY FOR STANDARDIZATION
(MAS)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: **ELECTROSTATIC DISCHARGE, MUNITIONS TEST PROCEDURES**

Promulgated on 13 October 1997

A. GRØNHEIM
Major General, NOAF
Chairman, MAS

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(Edition 1)

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardisation, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardisation, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page iii gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page iv (and subsequent) gives details of reservations and proprietary rights that have been stated.

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RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION	NATIONAL RATIFICATION REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION/MISE EN APPLICATION					
			FORECAST DATE PREVUE			ACTUAL DATE REELLE		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE								
CA								
DA	MA204.69-S4239/MAM3 - 03973 of/du 28.02.96					12.97	12.97	12.97
FR								
GE	BMVg-Fü S IV 2 Az 03-51-60 of/du 14.11.95		04.96	04.96	04.96			
GR	FN.069.1/128/217144 of/du 23.10.95							
IT								
LU	BO 3524/95 of/du 16.06.95			N.I			N.I	
NL	M95018106 of/du 26.09.95					09.97	01.97	01.97
NO	MAS-613/95/HST/U3/BØ STANAG 4239 of/du 27.07.95	STANAG 4239				01.96	01.96	01.96
PT								
SP								
TU	TUDEL-97/260 of/du 20.01.97			12.97		09.97	09.97	09.97
UK*	D/DSTAN/341/8/4239 of/14.07.95							
US	OUSD(A&T)S&TS/M of/du 22.11.96	STANAG 4239				11.96	11.96	11.96

* See overleaf reservations(*)/comments (+)
Voir au verso réserves (*)/commentaires (+)

RESERVES/RESERVATIONS

ROYAUME-UNI

Le Royaume-Uni veut réserver sa position quant au nombre de séquences d'essais mentionné dans le paragraphe 3.6 de l'Annexe A. Le Royaume-Uni utilisera un nombre de séquences et décharges déterminé par une évaluation des risques pour les munitions par suite des décharges électrostatiques.

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UNITED KINGDOM

The UK would reserve its position on the number of test sequences and discharges within a sequence as given in para 3.6 of Annex A. The UK would employ a number of sequences and discharges which would be determined by the assessed risk to the munitions from Electrostatic Discharge.

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NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT (STANAG)

ELECTROSTATIC DISCHARGE, MUNITIONS TEST PROCEDURES

Annexes: A. Electrostatic discharge test procedures to determine the safety and suitability for service of munitions and associated systems

B. Data sources

Related Documents:

STANAG 4235:	Electrostatic Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces;
STANAG 4238:	(Draft), Munition Design Principles, Electromagnetic Environment
STANAG 3516:	Electromagnetic Interference and Test Methods for Aircraft Electrical and Electronic Equipment
AOP-24:	Electrostatic Discharge, Munition Assessment and Test Procedures

AIM

1. The aim of this agreement is to define the test procedures to be used in determining the safety and suitability for service of munitions containing electro explosive devices (EEDs) and associated electrical/electronic systems/subsystems, in the electrostatic environmental conditions specified in STANAG 4235 for NATO forces. Guidance on electrostatic discharge (ESD) hazard assessment and testing is provided in AOP-24.

AGREEMENT

2. Participating nations agree:

a. that the electrostatic discharge test procedures specified in Annex A are adequate to determine the safety and suitability for service of munitions containing electro explosive devices (EEDs), and associated electrical/electronic subsystems which are required to be handled by personnel during the life cycle of the munition (and/or associated systems), or where the munitions or associated systems are required to be externally transported or launched by helicopter. The procedures shall also apply to parts of the munition or associated system that may be handled or transported separate from the complete system.

b. that AOP-24 be used to provide guidance in ESD hazard assessment and testing methods to support the required procedures given in Annex A of this STANAG.

c. to conduct ESD hazard assessments and, if deemed necessary, to utilize the test procedures of Annex A to certify munitions containing EEDs for use by NATO forces shall remain safe and suitable for service when subjected to the specified test levels.

d. that nations developing new munitions and weapon systems for use by NATO forces shall, for interoperability purposes, provide nations utilizing, storing, handling, or transporting munition containing EEDs information on:

(1) the results of any assessment made prior to testing, particularly if the assessment enables the nation developing the weapon to conclude that it is not susceptible to the environment defined by STANAG 4235 or that either of the threats is not relevant.

(2) the results of tests performed in accordance with the procedures detailed in Annex A.

(3) deviations from the test procedures discussed in Annex A which are used to establish the safety and suitability for service of EEDs and electrical/electronic subsystems in munitions.

e. that the NATO forces consider this STANAG as a basis for continuing a working relationship on assessment and testing.

IMPLEMENTATION OF THE AGREEMENT

3. This STANAG is considered implemented by a nation when that nation has issued the necessary orders or instructions to its forces:

(a) that all future munitions containing EEDs intended for use by NATO forces will be assessed and/or tested in accordance with the agreement

(b) to provide NATO forces with the information detailed in the agreement.

ELECTROSTATIC DISCHARGE TEST PROCEDURES TO DETERMINE THE SAFETY AND SUITABILITY FOR SERVICE OF MUNITIONS AND ASSOCIATED SYSTEMS

1. INTRODUCTION

1.1 There are many sources of electrostatic charge involved in the handling and deployment of munitions. STANAG 4235 defines the environments associated with the threat presented by personnel handling munitions and associated hardware and the threat presented by external transport or deployment on helicopters.

1.2 This document addresses testing using only the configuration(s) of munitions containing EED's and associated electrical/electronic systems likely to encounter the threat(s). Assessment of the need for testing is covered in Section 3 and in AOP-24.

1.3 Electrostatic Discharge (ESD) tests are used to determine whether the EEDs and/or electronic systems contained within a munition or associated system will remain safe and suitable for service after being exposed to the electrostatic discharge conditions likely to be encountered during NATO operations (as defined in STANAG 4235, "ELECTROSTATIC ENVIRONMENTAL CONDITIONS AFFECTING THE DESIGN OF MATERIEL FOR USE BY NATO FORCES"). During these tests the munition shall be in a passive state. Any associated electrical/electronic subsystem may be in either a passive or active state, depending upon the result of the assessment discussed in Section 3.

1.4. The electrostatic discharge levels of concern in this STANAG are those which may be generated by:

(1) personnel during preparation procedures (e.g. warheading), handling, maintenance, transportation and deployment of the munition containing EED's and associated electrical/electronic systems, or

(2) external transport or deployment of a munition containing EED's and associated electrical/electronic systems by a helicopter.

2. CIRCUIT PARAMETERS REPRESENTING THE ELECTROSTATIC DISCHARGE THREAT

Figure (1) provides a representation of the electrostatic discharge test system configuration for use in conducting the tests proposed in this STANAG. Tables 1 and 2 define the circuit parameters to be used in testing to represent the threat associated with personnel handling or external helicopter transport or deployment.

3. GENERAL REQUIREMENTS

3.1 An assessment of the ESD susceptibility of the munition and/or associated systems shall be conducted. Guidelines on conducting such an assessment are given in AOP-24. Where an analysis shows conclusively that munition containing EED's and associated electrical/electronic systems is not susceptible to the ESD threat or that the threat is not likely to be encountered, the requirement for testing may be waived upon approval by a recognized national authority.

3.2 Selection of the location of the test points for discharge testing shall be based on those points assessed to be potentially susceptible to either direct penetration or excitation of the structure and subsequent internal transfer of the energy. A discussion on techniques that may be used in the selection of discharge locations is given in AOP-24.

3.3 These tests are intended only to evaluate the response of the system's EED's and associated electrical/electronic systems to the threat of an ESD event. The items selected for testing shall be fully assembled with live EED's (or instrumented devices where approved by the national authority) and functional electronic subsystems, but with other explosive materials removed and replaced with inert materials that are electrically representative of the explosive materials.

3.4 The configuration of the item selected for testing shall be determined from an analysis of the life cycle (logistics and deployment) of the munition containing EED's and associated electrical/electronic systems. It may be necessary to test a weapon system in more than one configuration. Any protective caps or covers over connectors and/or shorting/grounding devices should be used during testing if they would be in place during the part of the logistics cycle simulated by the particular test.

3.5 Testing shall be conducted at a temperature of 23 $\pm$ 10°C and a relative humidity of less than 60 percent. The munition and its associated systems, along with relevant parts of the test hardware, should be conditioned to the temperature and relative humidity specified above for a minimum of 24 hours before testing. AOP-24 provides a discussion on the effect of moisture in the air and on (or just under) the surface of the test item when conducting such testing. Testing at other temperatures and relative humidities shall be conducted if these environments are expected to be encountered and the assessment indicates that the ESD threat is significantly higher or the munition is more sensitive in that environment.

3.6 A minimum of 20 test sequences shall be conducted when testing to the personnel-generated ESD threat. This minimum number of sequences is reduced to 10 when testing to the helicopter-generated threat. Testing conducted using fewer sequences than those stated above must be approved by the national authority prior to conducting such tests. For the purposes of this STANAG, a test sequence is defined as a series of discharges to the test item at the locations identified in the pre-test assessment to be potentially susceptible. Subsequent sequences may be conducted by using different items/equipments or on the same item/equipment with a different set of EEDs and electrical/electronic subsystems that have been confirmed to be functional within the weapon system specification. AOP-24 provides a discussion on the confidence level and reliability of test data versus the number of test sequences conducted without a failure.

4. TEST PLAN

A test plan shall be prepared for each item on which tests are conducted. This test plan shall include, but not be limited to, the following:

4.1 a description of the munition containing EEDs and associated electrical/electronic systems with identification of the configuration(s) to be tested;

4.2 the number of munitions and associated equipment to be used in the testing;

4.3 the number of times each munition and associated equipment may be tested;

4.4 the location of test points on the test item;

4.5 the type of data to be recorded (both written and pictorial) during the testing;

4.6 a separate test procedure for each threat level tested (i.e., personnel-generated (25 kV) threat and helicopter (300 kV) threat), and

4.7 a summary of results of any ESD tests conducted on the system's EEDs and/or electrical/electronic subsystems during qualification testing.

5. TEST EQUIPMENT

5.1 SIMULATION HARDWARE

A representation of the electrostatic discharge test system configuration for use in ESD testing of munitions and/or associated electrical/electronic systems is given in Figures (1) and (2) for the personnel-generated and helicopter-generated threats, respectively.

5.1.1 The power supply shall be capable of providing both a positive and negative output voltage.

5.1.2 The isolating switch shall isolate the capacitance from the power supply during the discharge of the capacitance onto the test item.

5.1.3 The test electrode shall be conductive and maintained to ensure high electrical conductivity. The shape of the electrode and its effect on ESD testing is discussed in AOP-24. Where it is desired to ensure that the discharge is directed to a particular point on the munition or associated system, a salient connection may be used. In such cases, testing or analysis shall be conducted to assure that the integument (i.e., outer skin) can withstand the arc discharge.

5.1.4 The impedance of the electrostatic voltmeter (or equivalent) shall be of such a value that it will not load the capacitance. It is recommended that the input impedance of the item used be greater than one teraohm (10^{12} ohms).

5.1.5 The series resistance, R, shall be non-inductive.

5.2 CALIBRATION OF THREAT SIMULATION HARDWARE

The test equipment shall be calibrated immediately prior to testing and after the completion of testing. AOP-24 discusses suitable procedures for such calibration. As a minimum, the voltage output waveform for the personnel threat simulation hardware shall be recorded across a standard test load and included in the test report. The standard test load is discussed in AOP-24. It shall be of coaxial configuration and designed and produced so as to have a linear response over the frequency range of DC-to-100 megahertz. The data acquisition hardware used to record the calibration waveforms from the personnel threat simulation hardware shall also have a frequency range of DC-to-100 megahertz.

6. TEST PROCEDURE

6.1 GENERAL

6.1.1 This section provides a general outline of the procedures to be used in the ESD testing of munitions containing EEDs and any associated electrical/electronic systems. A test procedure detailing the exact steps to be taken must be developed for use by those personnel conducting the testing.

6.1.2 The voltage, capacitance, series resistance, and discharge circuit inductance (including all wiring between the capacitance simulating the threat and electrode) for each of the simulated threats shall be in accordance with the values given in Table 1. Inductance shall be measured at a nominal one kilohertz frequency. Each test point selected shall be tested to each of the levels given in the table which have been assessed to be relevant.

6.1.3 Munition systems testing has shown some instances where an item may pass a high voltage test and fail at a lower voltage or higher resistance. Table 2 provides supplemental test parameters that may be selected for inclusion in the test plan to account for this possibility.

6.2 SPECIFIC PROCEDURES

6.2.1 Functional tests of the electronic subsystems to be tested shall be conducted prior to and after the testing. Resistances of each of the EEDs shall be recorded prior to and after any testing.

6.2.2. The munition and/or associated system(s) tested shall be positioned in a manner such that the threat can be directed to the first designated test point. The threat may be delivered by the use of an approaching electrode, a fixed gap, or a direct attachment such as through the use of a salient. AOP-24 contains a discussion on the energy delivery techniques that may be used. The energy delivery technique selected will affect the application of the general procedures.

6.2.3 The capacitance, C, shall be charged to the selected voltage level with positive polarity.

6.2.4 After the capacitance is fully charged, the energy in the capacitance shall be transferred to the test electrode. During this time the power supply shall be isolated from the capacitance.

6.2.5 Reposition the munition and/or associated system(s) to allow threat to be directed to the next designated test point and repeat steps 6.2.2 through 6.2.4 for each of the test points selected.

6.2.6 After the simulation hardware and test item are determined to be "safe", measurement of the resistances of each of the EEDs shall be made and compared with the initial values for evidence of compliance with the weapon system specification.

6.2.7 The test procedures in 6.2.1 through 6.2.6 shall be repeated with the same equivalent circuit parameters but with negative polarity.

6.2.8 Repeat the above procedures for each of the voltage and resistance parameters specified by the assessment.

6.2.9 After these measurements have been made, functional testing of the EED's and the electronic subsystems shall be conducted.

7. REPORTING REQUIREMENTS

7.1 A test report shall be provided following the completion of the test. This test report shall include, but not be limited to, the following:

7.1.1 the test plan.

7.1.2 previous testing

7.1.3 any waivers relative to the test conditions or operational plan (with rationale),

7.1.4 performance specifications of electronic subsystems, fuzing systems, and EEDs for use in the evaluation of the systems after being subjected to the ESD threat,

7.1.5 a complete description of the test equipment with circuit parameters and dimensions of the electrode used during testing,

7.1.6 a description of the calibration technique used,

7.1.7 a listing of rise time, fall time, and peak voltage measured for both 500 and 5000 ohm series resistance (25 kV testing only). Rise and fall times shall be measured using 10% to 90% values,

7.1.8 voltage waveforms recorded during calibration of the simulation hardware,

7.1.9 the results of testing conducted at each of the test points selected,

7.1.10 the results of operational system checks before and after tests (noting any significant changes),

7.1.11 a record of the EED's resistance(s) measured before and after each of the test sequences,

7.1.12 analyses, conclusions, and recommendations based on acceptance criteria and test results.

7.2 When analysis of the susceptibility of the munition or associated systems shows conclusively that the system is not susceptible to the ESD threats specified in STANAG 4235 or that the threat is not likely to be encountered, ESD testing may be waived by the national authority. The complete analysis shall be provided in lieu of a test report.

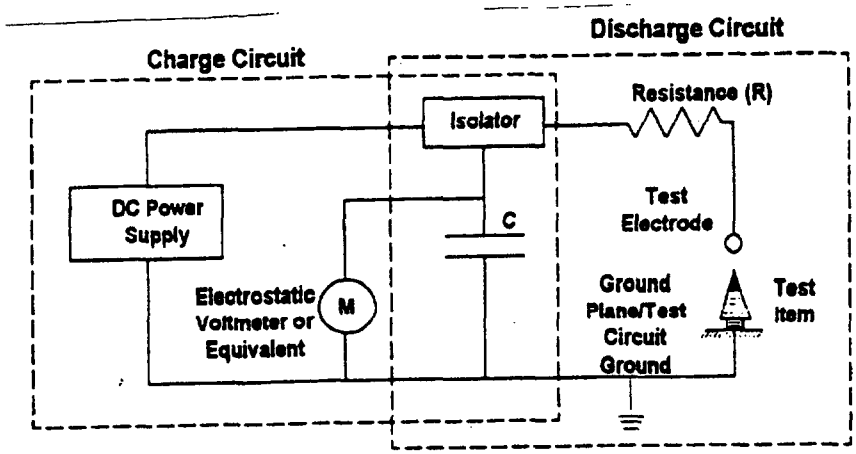

Figure 1. Functional Electrical Schematic for personnel-generated electrostic discharge test arrangement

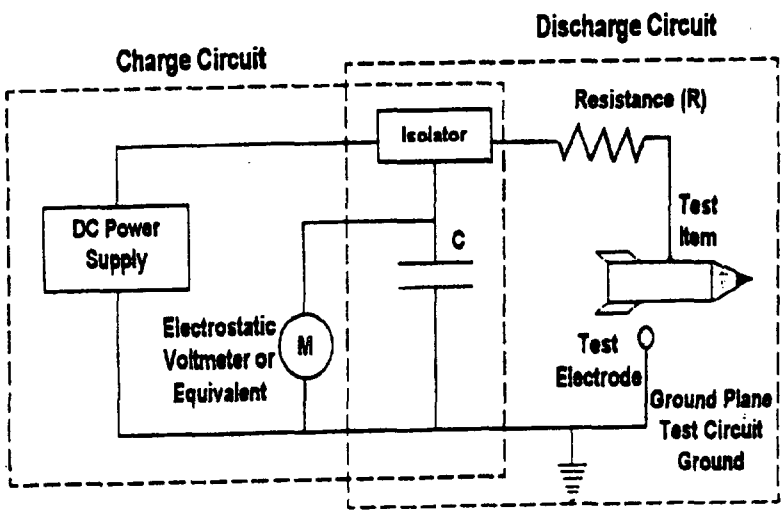

Figure 2. Functional electrical Schematic for Helicopter-generated electrostatic discharge test arrangement

TABLE 1

TEST PARAMETERS

Source of Threat	Voltage Across Capacitance (kV)	Capacitance (pF)	Series Resistance (Ohms)	Discharge Inductance (μH)
Personnel	±25 ± 5%	500 ± 5%	5000 ± 5%	<5
Personnel	±25 ± 5%	500 ± 5%	500 ± 5%	<5
Helicopter	±300 ± 5%	1000 ± 10%	1 max*	<20

* Total distributed discharge circuit resistance measured within an accuracy of 5%

TABLE 2

SUPPLEMENTAL TEST PARAMETERS

Source of Threat	Voltage Across Capacitance (kV)	Capacitance (pF)	Series Resistance (Ohms)	Discharge Inductance (µH)
Personnel	±20 ± 5%	500 ± 5%	5000 ± 5%	<5
Personnel	±20 ± 5%	500 ± 5%	500 ± 5%	<5
Personnel	±15 ± 5%	500 ± 5%	5000 ± 5%	<5
Personnel	±15 ± 5%	500 ± 5%	500 ± 5%	<5
Personnel	±10 ± 5%	500 ± 5%	5000 ± 5%	<5
Personnel	±10 ± 5%	500 ± 5%	500 ± 5%	<5
Personnel	± 5 ± 5%	500 ± 5%	5000 ± 5%	<5
Personnel	± 5 ± 5%	500 ± 5%	500 ± 5%	<5
Helicopter	±250 ± 5%	1000 ± 5%	1 max*	<20
Helicopter	±200 ± 5%	1000 ± 10%	1 max*	<20
Helicopter	±150 ± 5%	1000 ± 10%	1 max*	<20
Helicopter	±100 ± 5%	1000 ± 10 %	1 max*	<20
Helicopter	± 50 ± 5%	1000 ± 10 %	1 max*	<20
Helicopter	± 25 ± 5%	1000 ± 10 %	1 max*	<20

* Total distribution discharge circuit resistance, measured within an accuracy of 5%.

DATA SOURCES

International Electrotechnical Commission

(1)* IEC 801-2, "Electrostatic Discharge Test Methods for Electronic Systems".

Germany

(2)* VG 95378, "Electromagnetic Compatibility of Electro-Explosive Devices (EED); Test Method for Proof of Immunity to Disturbance of EEDs Toward Pulses for Electrostatic Discharge", Part 11, Bundesamt fuer Wertechnik und Beschaffung, Koeln.

United Kingdom

(3) UK Ministry of Aviation, "Measurement of Human Capacitance and Resistance in Relation to Electrostatic Hazards with Primary Explosives," Explosives Research and Development Establishment, Report No. 18/R/62, Waltham Abbey, 17 August 1962.

(4) Rogers and Minehan, "Variation of Helicopter Capacitance with Altitude," RAE Tech Note IEE 43, April 1964.

(5) Odam, Willis, and Rogers, "Static Electricity Measurements on Whirlwind 10, CH-37, CH-34 and HU-1B at RAF Old Sarum May 1967," RAE Tech Note IEE 182, October 1967.

(6) Odam, G.A.M., "Electrostatic Charging of Aircraft in Flight," Proceedings of 1st International Conference on Static Electricity, Vienna, May 1970.

(7) Odam, Evans, Little, and Butterfield, "Electrostatic Hazards in Helicopter SAR," Proceedings of 1st Aerospace Conference on Lightning and Static Electricity, Oxford, March 1982.

(8) Little, Butterfield and Odam, "Electrostatic Hazards to Winchmen," Culham Laboratory Report CLM/RR/M11/6, Oxford, June 1982.

* Edition of document in effect at the date this edition was published.

United States

(9)* MIL-STD-1512, "Electro explosive Subsystems, Electrically Initiated; Design Requirements and Test Methods."

(10)* MIL-I-23659, "Initiators; Electrical Design Specifications for."

(11)* MIL-STD-331, "Fuze and Fuze Components; Environmental and Performance Test for," Test Method F-1; Electrostatic Discharge Tests.

(12)* MIL-STD-1686, "Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)."

(13)* MIL-HDBK-263, "Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)."

(14)* MIL-STD-882, "System Safety Program Requirements."

(15) Siebert, James M., "Helicopter Static Electricity Measurements," U.S. Army Transportation Research Center, Technical Report 69-72, June 1962.

(16) Becher, M.C., "Investigation of CH-54A Electrostatic Charging of Active Electrostatic Discharge Capabilities," U.S. Army Aviation Material Laboratories, Technical Report 69-90, January 1970.

(17) Ponds, Charles D., "Electromagnetic (EM) Criteria for U.S. Army Missile Systems: Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP), Electrostatic Discharge (ESD), and Lightning," U.S. Army Missile Command, Technical Report TR-RT-81-5, Huntsville, AL, March 1981.

* Edition of document in effect at the date this edition was published.